

Practitioner's Docket No. 390P007204-US (PAR)

**PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Box Patent Application  
Assistant Commissioner for Patents  
Washington, D.C. 20231

**NEW APPLICATION TRANSMITTAL**

Transmitted herewith for filing is the patent application of

Inventor(s): Douglas R. Adams

**WARNING:** Patent must be applied for in the name(s) of all of the actual inventor(s). 37 CFR 1.41(a) and 1.53(b).

For (title): Substrate Processing Apparatus With Small Batch  
Load Lock

**CERTIFICATION UNDER 37 C.F.R. 1.10\***

(Express Mail label number is **mandatory**.)

(Express Mail certification is **optional**.)

I hereby certify that this New Application Transmittal and the documents referred to as attached therein are being deposited with the United States Postal Service on this date 3/27/98 in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EM174708875US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Shauna Murphy  
(type or print name of person mailing paper)

Shauna Murphy  
Signature of person mailing paper

**WARNING:** Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

**\*WARNING:** Each paper or fee filed by "Express Mail" **must** have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. 1.10(b).

"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

(Application Transmittal [4-1]—page 1 of 9)

## 1. Type of Application

This new application is for a(n)

(check one applicable item below)

- ☒ Original (nonprovisional)  
☐ Design  
☐ Plant

**WARNING:** Do not use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.

**WARNING:** Do not use this transmittal for the filing of a provisional application.

**NOTE:** If one of the following 3 items apply, then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED and a NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION.

- ☐ Divisional.  
☐ Continuation.  
☐ Continuation-in-part (C-I-P).

## 2. Benefit of Prior U.S. Application(s) (35 U.S.C. 119(e), 120, or 121)

**NOTE:** If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

**WARNING:** If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. 120, 121 or 365(c). (35 U.S.C. 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.

**WARNING:** When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application must be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).

- ☒ The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

## 3. Papers Enclosed That Are Required for Filing Date under 37 C.F.R. 1.53(b) (Regular) or 37 C.F.R. 1.153 (Design) Application

17 Pages of specification

7 Pages of claims

1 Pages of Abstract

4 Sheets of drawing

- ☐ formal  
☐ informal

**WARNING:** DO NOT submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. Comments on proposed new 37 CFR 1.84. Notice of March 9, 1988 (1990 O.G. 57-62).

**NOTE:** "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page." 37 C.F.R. 1.84(c)).

(complete the following, if applicable)

- ☐ The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. 1.84(b).

**4. Additional papers enclosed**

- ☐ Preliminary Amendment  
☐ Information Disclosure Statement (37 C.F.R. 1.98)  
☒ Form PTO-1449 (PTO/SB/08A and 08B)  
☒ Citations  
☐ Declaration of Biological Deposit  
☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.  
☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative  
☐ Special Comments  
☐ Other

**5. Declaration or oath**

- ☒ Enclosed  
Executed by

(check all applicable boxes)

- ☒ inventor(s).  
☐ legal representative of inventor(s).  
37 CFR 1.42 or 1.43.  
☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.  
☐ This is the petition required by 37 CFR 1.47 and the statement required by 37 CFR 1.47 is also attached. See item 13 below for fee.

- ☐ Not Enclosed.

**WARNING:** Where the filing is a completion in the U.S. of an International Application, but where a declaration is not available, or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

- ☐ Application is made by a person authorized under 37 C.F.R. 1.41(c) on behalf of all the above named inventor(s).

*(The declaration or oath, along with the surcharge required by 37 CFR 1.16(e) can be filed subsequently).*

NOTE: It is important that all the correct inventor(s) are named for filing under 37 CFR 1.41(c) and 1.53(b).

- ☐ Showing that the filing is authorized.  
(not required unless called into question. 37 CFR 1.41(d))

## 6. Inventorship Statement

**WARNING:** If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.

The inventorship for all the claims in this application are:

- ☒ The same.

or

- ☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,  
☐ is submitted.  
☐ will be submitted.

## 7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. A verified English translation of the non-English language application and the processing fee of \$130.00 required by 37 CFR 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 CFR 1.52(d).

NOTE: A non-English oath or declaration in the form provided or approved by the PTO need not be translated. 37 CFR 1.69(b).

- ☒ English  
☐ Non-English  
☐ The attached translation is a verified translation. 37 C.F.R. 1.52(d).

## 8. Assignment

- ☒ An assignment of the invention to Brooks Automation Inc.

- ☒ is attached. A separate ☒ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

- ☐ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters—one for the application and one for the assignment." Notice of May 4, 1990 (1114 O.G. 77-78).

**WARNING:** A newly executed "CERTIFICATE UNDER 37 CFR 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.

## 9. Certified Copy

Certified copy(ies) of application(s)

Country	Appln. No.	Filed
Country	Appln. No.	Filed
Country	Appln. No.	Filed

from which priority is claimed

☐ is (are) attached.

☐ will follow.

*NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 CFR 1.55(a) and 1.63.*

*NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.*

## 10. Fee Calculation (37 C.F.R. 1.16)

A. ☒ Regular application

CLAIMS AS FILED				
Number filed	Number Extra		Rate	Basic Fee 37 C.F.R. 1.16(a) \$790.00
Total				
Claims (37 CFR 1.16(c)) 29 – 20 =	9	×	\$ 22.00	198.00
Independent				
Claims (37 CFR 1.16(b)) 4 – 3 =	1	×	\$ 82.00	82.00
Multiple dependent claim(s), if any (37 CFR 1.16(d))				
		+	\$270.00	

☐ Amendment cancelling extra claims is enclosed.

☐ Amendment deleting multiple-dependencies is enclosed.

☐ Fee for extra claims is not being paid at this time.

*NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 CFR 1.16(d).*

Filing Fee Calculation

\$ 1,070.00

- B. ☐ Design application  
(\$330.00—37 CFR 1.16(f))

Filing Fee Calculation \$ \_\_\_\_\_

- C. ☐ Plant application  
(\$540.00—37 CFR 1.16(g))

Filing fee calculation \$ \_\_\_\_\_

**11. Small Entity Statement(s)**

- ☐ Verified Statement(s) that this is a filing by a small entity under 37 CFR 1.9 and 1.27 is (are) attached.

**WARNING:** *"Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. A nonprovisional application claiming benefit under 35 U.S.C. 119(e), 120, 121 or 365(c) of a prior application may rely on a verified statement filed in the prior application if the nonprovisional application includes a reference to a verified statement in the prior application or includes a copy of the verified statement filed in the prior application if status as a small entity is still proper and desired." 37 C.F.R. § 1.28(a).*

*(complete the following, if applicable)*

- ☐ Status as a small entity was claimed in prior application  
\_\_\_\_\_ / \_\_\_\_\_, filed on \_\_\_\_\_, from which benefit  
is being claimed for this application under:

- 35 U.S.C. ☐ 119(e),  
☐ 120,  
☐ 121,  
☐ 365(c),

and which status as a small entity is still proper and desired.

- ☐ A copy of the verified statement in the prior application is included.

Filing Fee Calculation (50% of A, B or C above)

\$ \_\_\_\_\_

**NOTE:** *Any excess of the full fee paid will be refunded if a verified statement and a refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 CFR 1.28(a).*

**12. Request for International-Type Search (37 C.F.R. 1.104(d))**

*(complete, if applicable)*

- ☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

**13. Fee Payment Being Made at This Time**

☐ Not Enclosed

☐ No filing fee is to be paid at this time.

*(This and the surcharge required by 37 C.F.R. 1.16(e) can be paid subsequently.)*

☒ Enclosed

☒ Filing fee \$ 1,070.00

☒ Recording assignment  
(\$40.00; 37 C.F.R. 1.21(h))  
(See attached "COVER SHEET FOR  
ASSIGNMENT ACCOMPANYING NEW  
APPLICATION".) \$ 40.00

☐ Petition fee for filing by other than all the  
inventors or person on behalf of the inventor  
where inventor refused to sign or cannot be  
reached  
(\$130.00; 37 C.F.R. 1.47 and 1.17(h)) \$ \_\_\_\_\_

☐ For processing an application with a  
specification in  
a non-English language  
(\$130.00; 37 C.F.R. 1.52(d) and 1.17(k)) \$ \_\_\_\_\_

☐ Processing and retention fee  
(\$130.00; 37 C.F.R. 1.53(d) and 1.21(l)) \$ \_\_\_\_\_

☐ Fee for international-type search report  
(\$40.00; 37 C.F.R. 1.21(e)) \$ \_\_\_\_\_

**NOTE:** 37 CFR 1.21(l) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 CFR 1.53(d) and this, as well as the changes to 37 CFR 1.53 and 1.78, indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(l) must be paid, within 1 year from notification under § 53(d).

Total fees enclosed \$ 1110.00

**14. Method of Payment of Fees**

☒ Check in the amount of \$ 1,110.00

☐ Charge Account No. \_\_\_\_\_ in the amount of  
\$ \_\_\_\_\_

A duplicate of this transmittal is attached.

**NOTE:** Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 CFR 1.22(b).

**15. Authorization to Charge Additional Fees**

**WARNING:** If no fees are to be paid on filing, the following items should not be completed.

**WARNING:** Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.

- ☒ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 16-1350:

☒ 37 C.F.R. 1.16(a), (f) or (g) (filing fees)

☒ 37 C.F.R. 1.16(b), (c) and (d) (presentation of extra claims)

**NOTE:** Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 CFR 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

☒ 37 C.F.R. 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)

☒ 37 C.F.R. 1.17 (application processing fees)

**WARNING:** While 37 CFR 1.17(a), (b), (c) and (d) deal with extensions of time under § 1.136(a), this authorization should be made only with the knowledge that: "Submission of the appropriate extension fee under 37 C.F.R. 1.136(a) is to no avail unless a request or petition for extension is filed." (Emphasis added). Notice of November 5, 1985 (1060 O.G. 27).

☐ 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

**NOTE:** Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 CFR 1.311(b).

**NOTE:** 37 CFR 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . issue fee." From the wording of 37 CFR 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

**16. Instructions as to Overpayment**

☒ Credit Account No. 16-1350

☐ Refund

  
SIGNATURE OF PRACTITIONER

Reg. No. 31,686

Mark F. Harrington  
(type or print name of attorney)

Tel. No. (203) 259-1800

Perman & Green, LLP  
P.O. Address

Customer No.

425 Post Road, Fairfield, CT 06430



☒ **Incorporation by reference of added pages**

*(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)*

- ☒ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added 5

- ☐ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added \_\_\_\_\_

- ☐ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added \_\_\_\_\_

- ☐ **Statement Where No Further Pages Added**

*(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)*

- ☐ This transmittal ends with this page.

**ADDED-PAGES FOR APPLICATION TRANSMITTAL WHERE BENEFIT OF  
PRIOR U.S. APPLICATION(S) CLAIMED**

NOTE: See 37 CFR 1.78(a).

**17. Relate Back**

**WARNING:** If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. 120, 121 or 365(c). (35 U.S.C. 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.

(complete the following, if applicable)

☐ Amend the specification by inserting, before the first line, the following sentence:

**A. 35 U.S.C. 119(e)**

NOTE: "Any nonprovisional application claiming the benefit of one or more prior filed copending provisional applications must contain or be amended to contain in the first sentence of the specification following the title a reference to each such prior provisional application, identifying it as a provisional application, and including the provisional application number (consisting of series code and serial number)." 37 C.F.R. § 1.78(a)(4).

☒ "This application claims the benefit of U.S. Provisional Application(s) No(s):

**APPLICATION NO(S):**

**FILING DATE**

60 / 044,490  
\_\_\_\_\_  
\_\_\_\_\_

4 / 21 / 97 "  
\_\_\_\_\_  
\_\_\_\_\_

**B. 35 U.S.C. 120, 121 and 365(c)**

NOTE: "Any nonprovisional application claiming the benefit of one or more prior filed copending nonprovisional applications or international applications designating the United States of America must contain or be amended to contain in the first sentence of the specification following the title a reference to each such prior application, identifying it by application number (consisting of the series code and serial number) or international application number and international filing date and indicating the relationship of the applications. Cross-references to other related applications may be made when appropriate." (See § 1.14(b)). 37 C.F.R. § 1.78(a)(2).

- ☐ "This application is a  
☐ continuation  
☐ continuation-in-part  
☐ divisional

of copending application(s)

- ☐ application number 0 / \_\_\_\_\_ filed on \_\_\_\_\_"  
☐ International Application \_\_\_\_\_ filed on \_\_\_\_\_  
\_\_\_\_\_ and which designated the U.S."

NOTE: The proper reference to a prior filed PCT application that entered the U.S. national phase is the U.S. serial number and the filing date of the PCT application that designated the U.S.

NOTE: (1) Where the application being transmitted adds subject matter to the International Application, then the filing can be as a continuation-in-part or (2) if it is desired to do so for other reasons then the filing can be as a continuation.

- ☐ "The nonprovisional application designated above, namely application \_\_\_\_\_ / \_\_\_\_\_, filed \_\_\_\_\_, claims the benefit of U.S. Provisional Application(s) No(s).:

**APPLICATION NO(S):**

**FILING DATE**

_____ / _____	_____ "
_____ / _____	_____ "
_____ / _____	_____ "

NOTE: The deadline for entering the national phase in the U.S. for an international application was clarified in the Notice of April 28, 1987 (1079 O.G. 32 to 46) as follows:

"The Patent and Trademark Office considers the International application to be pending until the 22nd month from the priority date if the United States has been designated and no Demand for International Preliminary Examination has been filed prior to the expiration of the 19th month from the priority date and until the 32nd month from the priority date if a Demand for International Preliminary Examination which elected the United States of America has been filed prior to the expiration of the 19th month from the priority date, provided that a copy of the international application has been communicated to the Patent and Trademark Office within the 20 or 30 month period respectively. If a copy of the international application has not been communicated to the Patent and Trademark Office within the 20 or 30 month period respectively, the international application becomes abandoned as to the United States 20 or 30 months from the priority date respectively. These periods have been placed in the rules as paragraph (h) of § 1.494 and paragraph (i) of § 1.495. A continuing application under 35 U.S.C. 365(c) and 120 may be filed anytime during the pendency of the international application."

### 18. Relate Back—35 U.S.C. 119 Priority Claim for Prior Application

The prior U.S. application(s), including any prior International Application designating the U.S., identified above in item 17B, in turn itself claim(s) foreign priority(ies) as follows:

Country	Appin. no.	Filed on
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The certified copy(ies) has (have)

- ☐ been filed on \_\_\_\_\_, in prior application 0 / \_\_\_\_\_, which was filed on \_\_\_\_\_.
- ☐ is (are) attached.

**WARNING:** The certified copy of the priority application that may have been communicated to the PTO by the International Bureau may not be relied on without any need to file a certified copy of the priority application in the continuing application. This is so because the certified copy of the priority application communicated by the International Bureau is placed in a folder and is not assigned a U.S. serial number unless the national stage is entered. Such folders are disposed of if the national stage is not entered. Therefore, such certified copies may not be available if needed later in the prosecution of a continuing application. An alternative would be to physically remove the priority documents from the folders and transfer them to the continuing application. The resources required to request transfer, retrieve the folders, make suitable record notations, transfer the certified copies, enter and make a record of such copies in the Continuing Application are substantial. Accordingly, the priority documents in folders of international applications that have not entered the national stage may not be relied on. Notice of April 28, 1987 (1079 O.G. 32 to 46).

### 19. Maintenance of Copendency of Prior Application

**NOTE:** The PTO finds it useful if a copy of the petition filed in the prior application extending the term for response is filed with the papers constituting the filing of the continuation application. Notice of November 5, 1985 (1060 O.G. 27).

#### A. ☐ Extension of time in prior application

(This item must be completed and the papers filed in the prior application, if the period set in the prior application has run.)

- ☐ A petition, fee and response extends the term in the pending prior application until \_\_\_\_\_.
- ☐ A copy of the petition filed in prior application is attached.

#### B. ☐ Conditional Petition for Extension of Time in Prior Application

(complete this item, if previous item not applicable)

- ☐ A conditional petition for extension of time is being filed in the pending prior application.
- ☐ A copy of the conditional petition filed in the prior application is attached.

## 20. Further Inventorship Statement Where Benefit of Prior Application(s) Claimed

NOTE: "If the continuation, continuation-in-part, or divisional application is filed by less than all the inventors named in the prior application a statement must accompany the application when filed requesting deletion of the names of the person or persons who are not inventors of the invention being claimed in the continuation, continuation-in-part, or divisional application." 37 CFR 1.62(a) [emphasis added] (dealing with the file wrapper continuation situation).

NOTE: "In the case of a continuation-in-part application which adds and claims additional disclosure by amendment, an oath or declaration as required by § 1.63 must be filed. In those situations where a new oath or declaration is required due to additional subject matter being claimed, additional inventors may be named in the continuing application. In a continuation or divisional application which discloses and claims only subject matter disclosed in a prior application, no additional oath or declaration is required and the application must name as inventors the same or less than all the inventors in the prior application." 37 CFR 1.62(c) (dealing with the continuation situation).

(complete applicable item (a), (b) and/or (c) below)

- (a) ☒ This application discloses and claims only subject matter disclosed in the prior application whose particulars are set out above and the inventor(s) in this application are

☒ the same.

☐ less than those named in the prior application. It is requested that the following inventor(s) identified for the prior application be deleted:

---

(type name(s) of inventor(s) to be deleted)

- (b) ☐ This application discloses and claims additional disclosure by amendment and a new declaration or oath is being filed. With respect to the prior application, the inventor(s) in this application are

☐ the same.

☐ the following additional inventor(s) have been added:

---

(type name(s) of inventor(s) to be added)

- (c) The inventorship for all the claims in this application are

☐ the same.

☐ not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made

☐ is submitted.

☐ will be submitted.

**21. Abandonment of Prior Application (if applicable)**

- ☐ Please abandon the prior application at a time while the prior application is pending, or when the petition for extension of time or to revive in that application is granted, and when this application is granted a filing date, so as to make this application copenending with said prior application.

**NOTE:** According to the Notice of May 13, 1983 (103, TMOG 6-7), the filing of a continuation or continuation-in-part application is a proper response with respect to a petition for extension of time or a petition to revive and should include the express abandonment of the prior application conditioned upon the granting of the petition and the granting of a filing date to the continuing application.

**22. Petition for Suspension of Prosecution for the Time Necessary to File an Amendment**

**WARNING:** "The claims of a new application may be finally rejected in the first Office action in those situations where (1) the new application is a continuing application of, or a substitute for, an earlier application, and (2) all the claims of the new application (a) are drawn to the same invention claimed in the earlier application, and (b) would have been properly finally rejected on the grounds of art of record in the next Office action if they had been entered in the earlier application." MPEP, § 706.07(b).

**NOTE:** Where it is possible that the claims on file will give rise to a first action final for this continuation application and for some reason an amendment cannot be filed promptly (e.g., experimental data is being gathered) it may be desirable to file a petition for suspension of prosecution for the time necessary.

(check the next item, if applicable)

- ☐ There is provided herewith a Petition To Suspend Prosecution for the Time Necessary to File An Amendment (New Application Filed Concurrently)

**23. Small Entity (37 CFR § 1.28(a))**

- ☐ Applicant has established small entity status by the filing of a verified statement in parent application /\_\_\_\_\_ on \_\_\_\_\_.
- ☐ A copy of the verified statement previously filed is included.

**WARNING:** See 37 CFR § 1.28(a).

**24. NOTIFICATION IN PARENT APPLICATION OF THIS FILING**

- ☐ A notification of the filing of this  
(check one of the following)
- ☐ continuation
  - ☐ continuation-in-part
  - ☐ divisional

is being filed in the parent application, from which this application claims priority under 35 U.S.C. § 120.

390P007204-US (PAR)

Patent Application Papers Of:

Douglas R. Adams

For: SUBSTRATE PROCESSING APPARATUS WITH  
SMALL BATCH LOAD LOCK

**SUBSTRATE PROCESSING APPARATUS WITH  
SMALL BATCH LOAD LOCK**

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 60/044,490, filed 4/21/97.

BACKGROUND OF THE INVENTION

5     1. Field of the Invention

The present invention relates to substrate processing apparatus and, more particularly, to load lock adapted to hold more than one set of substrates.

2. Prior Art

10    U.S. Patent 5,013,385 discloses a substrate processing apparatus. Load locks between substrate cassettes in atmospheric pressure and a vacuum chamber of a substrate processing apparatus are also known in the art.

SUMMARY OF THE INVENTION

15    In accordance with a first embodiment of the present invention, a substrate load lock is provided. The substrate load lock comprises a frame and a substrate support movably mounted to the frame. The frame forms at least three chambers. The substrate support has at least  
20    two separate support areas. A first one of the support areas is movable between a first one of the chambers and a second one of the chambers. The second one of the support areas is movable between the second chamber and a third one of the chambers.



In accordance with a second embodiment of the present invention, a substrate load lock is provided. The substrate load lock comprises a frame forming at least one sealable chamber, means for varying the environment of the chamber and at least two substrate supports. The substrate supports are movably connected to the frame. Each substrate support is alternately movable into the sealable chamber. When the sealable chamber is sealed, only one of the substrate supports is located therein.

10 In accordance with a third embodiment of the present invention, a substrate load lock is provided. The substrate load lock comprises a frame and a movable support attached to the frame. The frame has a chamber formed therein. The chamber has an upper substrate receiving opening and a lower substrate receiving opening. The movable support has an upper substrate support area and a lower substrate support area. The movable support reciprocates to alternately move the upper support area and the lower support area into the chamber. The upper support area is moved into the chamber through the upper substrate receiving opening. The lower support area is moved into the chamber through the lower substrate receiving opening.

25 In accordance with a method of the present invention, a method for transporting a substrate between a substrate processing device and a supply module is provided. The method comprises the steps of transporting the substrate between a movable first substrate support area in a load lock and a supply module, moving the first substrate support area within the load lock and transporting the substrate between the first substrate support area in the load lock and the substrate processing device. The first substrate support area is located in an initial position wherein a first substrate mechanism for transporting

substrates between the supply module and load lock has access to the first substrate support area. The first substrate support area is moved from the initial position to a final position within the load lock. In the final position, a second substrate transport mechanism has access to the first substrate support area. The second substrate support mechanism transports the substrate between the first substrate support area in the load and the substrate processing device.

#### 10 BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects and other features of the present invention are explained in the following description, taken in connection with the accompanying drawings, wherein:

15 Fig. 1 is a schematic top plan view of a substrate processing apparatus comprising features of the present invention;

Fig. 2 is a schematic cross-sectional side view of the apparatus shown in Fig. 1;

20 Fig. 3A is a schematic cross-sectional side view of the load lock shown in Fig. 2 with its substrate support at a down position; and

Fig. 3B is a schematic cross-sectional side view of the load lock shown in Fig. 3A with its substrate support at an intermediate position.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Fig. 1, there is shown a schematic top plan view of a substrate processing apparatus 10 incorporating features of the present invention. Although the present

invention will be described with reference to the single embodiment shown in the drawings, it should be understood that the present invention can be embodied in many alternate forms of embodiments. In addition, any  
5 suitable size, shape or type of elements or materials could be used.

The apparatus 10 includes a main section 12, substrate processing modules 14 and a substrate supply module 16. The main section 12 has a substrate transport 18 for  
10 moving substrates among the modules 14, 16. The substrate transport 18 is substantially the same as the transfer device described in PCT patent publication No. WO 94/23911 which is hereby incorporated by reference in its entirety. However, any suitable type of transport  
15 could be used. The chamber 30 formed by the main section 12 is preferably maintained in a vacuum. In alternate embodiments, the chamber formed by the main section may contain inert gases to enhance gas assisted processing. The substrate supply module 16 is connected to a front  
20 end 21 of the main section 12. Referring also to Fig. 2, the substrate supply module 16 is located outside the vacuum chamber 30. The substrate supply module 16 is open to the atmosphere. The supply module 16 has a frame 20, a substrate transport 22, and means for holding two  
25 substrate cassettes 24, 25. However, in alternate embodiments, any suitable type of substrate supply module could be provided. The substrate processing modules 14 are well known in the art and, therefore, will not be described further. The substrates S could be semi-  
30 conductor wafers, flat panel display substrates, or any other type of substrate.

In the preferred embodiment, the front end 21 of the main section has two load locks 26, 28. In alternate embodiments the main section may have more or fewer load

locks. In still other embodiments, the load locks may be located individually or in number at various different locations around the perimeter of the main section. The load locks 26, 28 function as an isolation compartment.

5 The load locks 26, 28 allow transport of substrates between the vacuum chamber 30 and the supply module 16; namely, between a vacuum environment and an atmospheric pressure environment. The atmospheric robot 22 transports the substrates from the cassettes 24, 25 to  
10 the load locks 26, 28 of the main section 12. The load locks 26, 28 are cycled so that the substrates therein may be transported into the vacuum chamber 30 without loss of vacuum. After the load locks 26, 28 are cycled, the vacuum chamber robot 18 transports the substrates  
15 from the load locks 26, 28 to the processing modules 14. When the substrates are finished being processed, the substrates are returned to the load locks. The vacuum chamber robot 18 transports the substrates from the modules 14 to the load locks 26, 28. The load locks 26,  
20 28 are then cycled to restore the substrates therein to atmospheric conditions. Finally, the atmospheric robot 22 transports the substrates from the load locks 26, 28 back to the cassettes 24, 25.

A problem was encountered with prior art systems in that  
25 the loading and unloading of batches of substrates by the atmospheric robot at a batch load lock, and the subsequent evacuation or pressurizing of the load lock, took too long. This meant that the vacuum chamber robot could not operate at a 100% duty cycle or, the  
30 atmospheric robot had to be operated so fast that the wafer handling problems occurred. The atmospheric robot did not work at a 100% duty cycle because it had to wait for the load lock to be pressurized. The process for transporting substrates between the supply module and  
35 main section was a linear or sequential process when

using the load locks of the prior art. The transport process substantially comprised four basic steps performed in linear succession, the sequence of steps being repeated until the transport of substrates was completed. For example, to load the substrates from the supply module into the main section, first, the atmospheric robot transported the substrates from the supply module into the load lock. Second, the environment inside the load locks was cycled to provide a vacuum condition therein. Third, after the environment in the load lock was cycled to vacuum, the vacuum chamber robot transported the substrates from the load lock to the main section. Fourth, after being filled with substrates from the robot 18, the environment of the load lock was cycled back to atmosphere before the atmospheric robot could unload the substrates from the load lock and commence the first step of the next transport sequence again. Both the atmospheric robot and the vacuum chamber robot could need to be idle during the time that the environment of the load lock was cycled between vacuum and atmosphere. Furthermore, the atmospheric robot could remain idle when the load lock was open to the vacuum chamber and the vacuum chamber robot transported substrates between load lock and main section. Conversely, the vacuum chamber robot could be idle when the load lock was open to atmosphere and transport operations between supply module and load lock were in progress. Therefore, the atmospheric robot and vacuum robot could be idle about 75% of the time under this process of the prior art. Introduction in the prior art of an additional separate load lock increased the efficiency of the substrate transport operation, but the atmospheric robot and vacuum chamber robot remained idle about 50% of the time. To reduce the idle time of the vacuum chamber robot, the atmospheric robot had to operate at maximum speed when loading and unloading

substrates. Nevertheless, the atmospheric robot remained idle waiting for access to the load lock. This type of hurry-up and wait operation slowed down the operation of the apparatus.

5 Referring still to Fig. 2, the load lock of the present invention overcomes the problem in the prior art by using a multi-chamber load lock. The two load locks 26, 28 are substantially the same, but have frames configured as left side and right side units. Thus, the invention will  
10 be described with reference to the load lock 26 only. The same description also applies to the load lock 28. Alternatively, the load lock 28 could be a different type of load lock. The load lock 26 has a frame 32 connected to the frame of the main section 12. The frame 32 has  
15 three chambers 34, 36, 38. In the preferred embodiment the chambers 34, 36, 38 are vertically offset. In alternate embodiments, the load lock may have the three chambers offset in any other suitable manner, such as a horizontal offset. The upper chamber 34 has a front  
20 aperture 40. The middle chamber 36 has a rear aperture 42. The bottom chamber 38 has a front aperture 44. The front aperture 40 of the upper chamber 34 and the front aperture 44 of the bottom chamber 38 are open to the ambient atmosphere. However, doors could be provided.  
25 The front apertures 40, 44 are adapted to allow the atmospheric robot 22 access into the upper chamber 34 and bottom chamber 38 respectively to transport substrates between the load lock 26 and the supply module 20. The rear aperture 42 of the middle chamber 36 opens into the  
30 vacuum chamber 30. The rear aperture 42 is adapted to allow the vacuum chamber robot 18 access into the middle chamber 36 to transport substrates between the load lock 26 and the main section 12. A movable door 46 is provided to close the rear aperture 42. The two front  
35 apertures 40, 44 do not need doors. The frame 32 has two

dividers 48, 50 that help to define the three chambers 34, 36, 38. The two dividers 48, 50 have passageway apertures 52, 54 and seals 56, 58, 60, 62. For the upper divider 48, the upper surface seal 56 is larger than the lower surface seal 58. For the lower divider 50, the upper surface seal 60 is smaller than the lower surface seal 62. The load lock 26 also has a movable substrate support 64. The support 64 has two support sections 66, 68. Each support section 66, 68 can hold a plurality of the substrates S. Thus, the support 64 is able to hold two separate sets of substrates. The movable support 64 extends substantially vertically within the frame 32 of the load lock 26. The movable support 64 spans through the middle chamber 36 within the passageway apertures 52, 54. The two support sections 66, 68 are vertically offset. The movable support 64 is movably mounted to the frame 32 of the load lock 26. The support 64 is moved in a generally vertical direction by a vertical drive motor 70 such as a hydraulically or pneumatically powered piston or other suitable linear actuator. In the preferred embodiment, the drive motor 70 is mounted to the frame 32 of the load lock. In alternate embodiments, the drive for the movable support may be mounted to any other suitable part of the processing apparatus 10. The drive motor 70 vertically moves the support 64 up and down, generally like a poppet, relative to the frame 32 of the load lock 26.

Referring now to Figs. 2 and 3A, Fig. 2 shows the movable support 64 in the up position and Fig. 3A shows the movable support 64 in the down position. The support sections 66, 68 are located on the movable support 64 so that when the support 64 is in the down position the upper support section 66 is in the middle chamber 36 and the lower support section 68 is in the bottom chamber 38 (see Fig. 3A). When the movable support 64 is in the up

position, the upper support section 66 is in the upper chamber 34 and the lower support section 68 is in the middle chamber 36. In the preferred embodiment, each support section 66, 68 supports the substrates loaded thereon in a vertically staggered orientation. In alternate embodiments the substrates supported by the support sections may be horizontally staggered. The two robots 18, 22 are adapted to move their substrate end effectors in vertical directions to move in and out of the apertures 40, 42, 44 at different heights. The movable support 64 includes a top plate 72, a middle plate 74 and a bottom plate 76. The top plate 72 is located on the movable support 64 above the upper support section 66. The middle plate 74 is located between the upper support section 66 and the lower support section 68 of the movable support 64. The bottom plate 76 is located below the lower support section 68. The top plate 72 is sized and shaped to contact and make a seal with the upper surface seal 56 when the support 64 is in a down position. The bottom plate 76 is sized and shaped to contact and make a seal with the lower surface seal 62 when the support is in an up position (see Fig. 2). The middle plate 74 is sized and shaped to alternatively contact and form a seal with the lower surface seal 58 in the up position or with the upper surface seal 60 in the down position. Hence, when the movable support 64 is in the down position, the top plate 72 closes the upper passageway aperture 52 and the middle plate 74 closes the lower passageway aperture 54 isolating the middle chamber 36 from the upper chamber 34 and the lower chamber 38 (see Fig. 3A). When the movable support 64 is in the up position, shown in Fig. 2, the middle plate 74 closes the upper passageway aperture 52 and the lower plate 76 closes the lower aperture 54 again isolating the middle chamber 36 from the upper chamber 34 and lower chamber 38. Otherwise, when the support 64 is in an interim



position, between the up and down positions, the middle chamber 36 communicates with the upper and lower chambers 34, 38 through the apertures 52, 54 (see Fig. 3B). In the preferred embodiment, the middle chamber 36 of the load lock 26 is connected to a source of vacuum 80 to evacuate the atmosphere in the chamber 36. The middle chamber also has an air inlet 82 to restore the atmosphere in the chamber 36 in a controlled manner. In alternate embodiments, the middle chamber of the load lock may be connected to a gas source to pressurize the chamber and a gas outlet to restore the chamber to atmospheric conditions in a controlled manner.

The drive motor 70 drives the movable support 64 of the load lock 26 upward to the up position shown in Fig. 2. With the movable support 64 in the up position, the upper support section 66 is located in the upper chamber 34 of the load lock 26. The atmospheric robot 22 can load and unload substrates through the top aperture 40 between the cassettes 24, 25 and the upper support section 66. The drive motor 70 maintains an upward force on the movable support 64 so that the middle plate 74 makes a sealing engagement with the lower seal 58 of the upper passageway aperture 52. The upward force exerted on the movable support 64 also drives the lower plate 76 to make a sealing engagement with the lower seal 62 of the lower passageway aperture 54. Thus, the middle chamber 36 is isolated from the upper and lower chambers 34, 38 and a vacuum environment may be introduced in the middle chamber 36. The air in the middle chamber 36 is evacuated by the vacuum source 80. In the embodiment shown, the seal 58 and middle plate 74 have been made smaller than the seal 62 and bottom plate 76. This has been done in order to harness atmospheric pressure as an aid in keeping the support 64 in the up position and keeping the middle chamber 36 sealed at the seals 58, 62

when the middle chamber 36 has a pressure less than atmospheric pressure. When the movable support 64 is in the up position and the middle chamber 36 has a pressure less than atmospheric pressure, the atmospheric pressure in the upper chamber 34 and bottom chamber 38 exerts a net upward force on the movable support 64. Atmospheric pressure in the bottom chamber 38 presses upward on the lower surface 77 of the bottom plate 76. Atmospheric pressure in the upper chamber 34 presses downward on the upper surface 73 of the middle plate 74. A net upward force on the movable support 64 is generated because the lower surface 77 of the bottom plate 76 has a larger area exposed to atmospheric pressure than the upper surface 73 of the middle plate 74. With the movable support 64 in the up position, the lower support section 68 is in the sealed middle chamber 34. After a vacuum is established in the middle chamber 34, the door 46 of aperture 42 may be opened without losing the integrity of the vacuum environment in the vacuum chamber 30. When the door 46 is open, the vacuum chamber robot 18 can remove and insert substrates on the lower support section 68 through the rear aperture 42 of the middle chamber 36. The door 46 is closed when the middle chamber 36 is pressurized in preparation for moving the support 64.

The drive motor 70 drives the movable support 64 downward relative to the frame 32, to the down position shown in Fig. 3A. In this position, the lower support section 68 is located in the bottom chamber 38 and the upper support section 66 is located in the middle chamber 36. The drive motor 70 maintains downward force on the support 64 so that the middle plate 74 makes sealing contact with the seal 60 and the top plate 72 makes sealing contact with the seal 56. Thus, the middle chamber 36 is again isolated from the upper and lower chambers 34, 38 and a vacuum may be introduced into the middle chamber 36. In

addition, the top plate 72 is larger than the middle plate 74 to assist in sealing the middle chamber 36. When the movable support 64 is in the down position and the pressure in the middle chamber 36 is less than atmospheric pressure, the atmospheric pressure in the upper chamber 34 and the atmospheric pressure in the bottom chamber 38 act on the upper and middle plates 72, 74 respectively to exert a net downward force on the movable support 64. The top plate 72 is larger than middle plate 74. Also, the seal 56 around the upper passageway aperture 52 has a larger perimeter than the perimeter of seal 60 on the lower passageway aperture 54. Hence, when the upper plate 72 is seated on the upper seal 56 and the lower plate is seated on the lower seal 60, the upper plate 72 has a larger surface 71 wetted by the atmosphere in the upper chamber 34 than the surface 75 of the middle plate 74 wetted by the atmosphere in the bottom chamber 38. The atmosphere in the upper chamber 34 presses the wetted area of the upper plate 72 to create a downward force on the upper plate 72. The atmosphere in the bottom chamber 38 presses on the smaller wetted area of the middle plate 74 creating an upward force on the middle plate 74. Hence, the net force exerted on the main support 64 is downward because the downward force on the upper plate 72 is larger than the upward force on the middle plate 74. This helps to insure that the middle chamber 36 remains sealed so the door 46 can be opened. With the support 64 in the down position, the atmospheric robot 22 can insert and remove substrates S through the bottom aperture 44 from the bottom support section 68. The door 46 of the aperture 42 is opened after a vacuum is established in the middle chamber 36. When the door 46 is open, the vacuum chamber robot 18 can then insert and remove substrates S from the upper support section 66 through aperture 42. The door 46 is closed again prior to pressurizing the middle

chamber 36 in preparation for returning the movable support 64 to its up position.

Referring also to Fig. 3B, the support 64 is shown at an intermediate position between the up position shown in Fig. 2 and the down position shown in Fig. 3A. When the support 64 moves up and down, the two passageway apertures 52, 54 in the dividers 48, 50 are not blocked. Thus, the three chambers 34, 36, 38 all have the same atmospheric pressure. The door 46 must be kept closed so as not to disturb the vacuum environment of the vacuum chamber 30. The computer controller 11 is programmed to prevent the atmospheric robot 22 from entering the apertures 40, 44, while the support 64 is being moved. This prevents damage to the movable support 64 and the atmospheric robot 22 resulting from a collision between them. The movable support 64 has appropriate sensors, such as limit switches, to signal the computer controller 11 when the movable support 64 is in the up or down positions or moving therebetween. An interlock prevents the computer controller 11 from moving the robot 22 unless the controller receives the signal that the support 64 is in the up or down positions. The computer controller 11 is programmed not to open the door 46 unless the middle chamber 36 is in a vacuum (the passageway apertures 52, 54 necessarily being blocked in order for this to occur). Preferably, the middle chamber has a pressure switch 86 to signal the computer controller 11 when a vacuum exists in the middle chamber 36. In addition, the computer controller 11 is programmed to not move the support 64 unless the door 46 is closed and the middle chamber 36 is at or very near atmospheric pressure. The pressure switch 86 signals the controller 11 when the middle chamber 36 is pressurized. Sensors on the movable support also signal the computer

controller 11 when the support sections 66, 68 are empty or full with substrates.

The process for transporting substrates between the supply module 20 and the main section 12 is as follows.

5 Initially, the movable support 64 of the load lock 26 may be in either its up position, shown in Fig. 2, or its down position, shown in Fig. 3A. The door 46 to the rear aperture 42 is closed and the middle chamber 36 is pressurized to atmospheric pressure. If the movable  
10 support 64 is down, the atmospheric robot 22 loads substrates from the cassettes 24, 26 into the lower support section 68 located in the bottom chamber 38 of the load lock 26. When the lower support section 68 is loaded with substrates, the computer controller 11 moves  
15 the movable support 64 to the up position (see Fig. 2). Then the lower support section 68 is moved from the bottom chamber 38 to the middle chamber 36, and the upper support section 66 is moved from the middle chamber 36 to the upper chamber 34 of the load lock 26. After the  
20 movable support 64 is in the up position, thereby sealing the middle chamber 36, the computer controller 11 evacuates the air from the middle chamber 36. The controller 11 opens the door 46 to the rear aperture 42 of the middle chamber 36 when the evacuation of the  
25 middle chamber 36 is completed. The vacuum chamber robot 18 then transports the substrates from the lower support section 68 in the middle chamber 36 to the main section 12 through the rear aperture 42. The vacuum chamber robot 18 may replace the unprocessed substrates removed  
30 from the lower support section 68 with previously processed substrates within the main section 12. In parallel with the evacuation of the middle chamber 36 and transporting of substrates between the vacuum chamber 30 and lower support section 68, the atmospheric robot 22  
35 transports substrates from the supply module 16 to the

upper support section 66 located in the upper chamber 34. After loading of the upper support section 66 and unloading (or reloading if appropriate) of the lower support section 68, the computer controller 11 closes the door 46. The middle chamber 36 is then pressurized to atmospheric pressure. When the pressure in the middle chamber 36 is substantially equal to atmospheric pressure, the computer controller 11 returns the movable support 64 to its down position (see Fig. 3A). The lower support section 68 is thus moved from the middle chamber 36 back to the bottom chamber 38, and the upper support section 66, loaded with unprocessed substrates, is moved from the upper chamber 34 to the middle chamber 36. Again, the air in the middle chamber 34 is evacuated and then the door 46 is opened. The vacuum chamber robot 18 commences transport of substrates from the upper support section 66 to the vacuum chamber 30. Any previously processed substrates are returned from the vacuum chamber 30 to the upper support section 66. Concurrent with the depressurization of the middle chamber 36 and removal or replacement of substrates from the upper support section 66, the atmospheric robot 22 removes any processed substrates on the lower support section 68 and replaces them with unprocessed substrates from the supply module 16. Upon completion of unloading and reloading of the upper support section 66 and the lower support section 68, the door 46 is closed and the middle chamber 36 is pressurized to atmospheric pressure. The movable support 64 is then moved back to the up position. The above cycle is repeated as necessary until the transport of substrates between the supply module 16 and main section 12 is completed. The present invention allows the atmospheric robot 22 to load or unload one set of substrates at either the top or bottom chambers while, at the same time, a second set of substrates is in the middle chamber during evacuation or pressurization of the

middle chamber or being moved by the vacuum chamber robot. Thus, the single load lock 26 of the present invention can perform almost as fast and with the same throughput as two conventional load locks.

5 As is known in the art, evacuation of a load lock chamber needs to be done relatively slowly, such as about two minutes. This is because, if evacuated too fast, water vapor in the air will condense into water droplets on the substrates. Also as is known in the art, returning a  
10 load lock to atmospheric pressure needs to be done relatively slowly to prevent the air from moving the substrates. The load lock chambers are preferably not large because of the problems encountered with evacuation and time. Thus, a load lock for relatively large  
15 substrates, such as wafers having a 300 mm diameter or more, because of time constraints, will only be able to hold a small batch of substrates due to size constraints of the evacuation chamber. The present invention allows both of the robots 18, 22 to operate at or very close to  
20 peak duty cycle without increasing the footprint of the apparatus 10, without having to add additional conventional load locks, without having to run the atmospheric robot 22 at an excessive speed, and without speeding up or changing the small batch evacuation  
25 procedures of the load lock. In addition, the motor 70 does not need to be an expensive indexer motor. The motor 70 need only be a less expensive two position motor. Because the middle chamber 36 is relatively small, a compact vacuum pump can be used. The present  
30 invention overcomes the problem of the prior art atmospheric robot down time and potentially excessive catch-up speed. The atmospheric robot 22 can now operate at a slower safer speed without slowing down the operation of the vacuum chamber robot 18. The ability of  
35 the atmospheric robot 22 to have almost continuous access

to either the upper section 66 or the lower support section 68 without changing the general evacuation and pressurizing scheme of the load lock can also allow higher substrate throughput to occur. The present invention could be used for larger batches of substrates and smaller size substrates. Doors could be used at the front apertures 40, 44, such as if all three chambers were normally maintained in a vacuum except when either the top or bottom chamber was being used with the atmospheric robot 22. A load lock with more than three chambers and/or more than two substrate support sections could be used. Rather than merely vertical movement, the substrate support could move in other paths or directions. The load lock could also be used in any suitable type of substrate processing apparatus.

It should be understood that the foregoing description is only illustrative of the invention. Various alternatives and modifications can be devised by those skilled in the art without departing from the invention. Accordingly, the present invention is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.



## CLAIMS

What is claimed is:

1. A substrate load lock comprising:  
  
a frame forming at least three chambers; and  
  
a substrate support movably mounted to the frame, the substrate support having at least two separate support areas, a first one of the support areas being movable between a first one of the chambers and a second one of the chambers and, a second one of the support areas being movable between the second chamber and a third one of the chambers.
2. A substrate load lock as in Claim 1, wherein the second chamber has an upper opening communicating with the first chamber, the opening being adapted to admit the first support area therethrough.
3. A substrate load lock as in Claim 1, wherein the second chamber has a lower opening communicating with the third chamber, the opening being adapted to admit the second support area therethrough.
4. A substrate load lock as in Claim 1, wherein the second chamber had a first hole communicating with the first chamber and a second hole communicating with the third chamber and wherein the substrate support extends through the second chamber within the first hole and the second hole.
5. A substrate load lock as in Claim 1, wherein the substrate support comprises means for sealing the second chamber from the first chamber and the third chamber.
6. A substrate load lock as in Claim 5, wherein the means for sealing the second chamber comprise the

substrate support having three seal members thereon located so that the first support area is between a first one of the seal members and a second one of the seal members, and the second support area is between the second seal member and a third one of the seal members.

7. A substrate load lock as in Claim 6, wherein the first seal member and the second seal member seal the second chamber when the first support area is in the second chamber, and the second seal member and the third seal member seal the second chamber when the second support area is in the second chamber.

8. A substrate load lock as in Claim 1, wherein the second chamber has a closable aperture adapted to allow a substrate to pass therethrough when the substrate is being transported between the load lock and a substrate processing device.

9. A substrate load lock as in Claim 1, wherein the first chamber has a first substrate transport aperture through which substrates are transported between a supply module and the first support area when the first support area is in the first chamber, and wherein the third chamber has a second substrate transport aperture discrete from the first substrate transport aperture, the second substrate transport aperture allowing substrates to be transported between the supply module and the second support area when the second support area is in the third chamber.

10. A substrate load lock as in Claim 1, wherein the first support area and the second support area each have a plurality of supports so that each support area may support a plurality of substrates.

11. A substrate load lock comprising:

a frame forming at least one sealable chamber;

means for varying the environment of the chamber;  
and

at least two substrate supports movably connected to the frame so that each substrate support is alternately movable into the sealable chamber;

wherein, when the sealable chamber is sealed, only one of the substrate supports is located therein.

12. A substrate load lock as in Claim 11, wherein the two substrate supports are moved by a common actuator mounted to the frame.

13. A substrate load lock as in Claim 12, wherein the actuator has a reciprocating member within the frame, the two substrate supports being connected to the reciprocating member so that the two substrate supports reciprocate in phase with the reciprocating member in a direction substantially parallel to a stroke of the reciprocating member.

14. A substrate load lock as in Claim 12, wherein the actuator is a poppet moving a first one of the substrate supports between an upper chamber of the load lock and the sealable chamber, and moving a second one of the substrate supports between a lower chamber of the load lock and the sealable chamber.

15. A substrate load lock as in Claim 12, wherein the sealable chamber has an upper aperture communicating with an upper chamber of the load lock and a lower aperture communicating with a lower chamber of the load lock.

16. A substrate load lock as in Claim 15, wherein the actuator has a reciprocating member within the frame,

the reciprocating member having seal plates thereon to seal the upper aperture and lower aperture of the sealable chamber when each of the two substrate supports is located therein.

17. A substrate load lock as in Claim 16, wherein the reciprocating member has three of the seal plates, an upper one of the seal plates being adapted to engage an upper seal of the upper aperture to close the upper aperture, a bottom one of the seal plates being adapted to engage a lower seal of the lower aperture to close the lower aperture and a middle one of the seal plates being adapted to engage a lower seal of the upper aperture to close the upper aperture and being adapted to alternatively engage an upper seal of the lower aperture to close the lower aperture.

18. A substrate load lock as in Claim 17, wherein the middle seal plate closes the upper aperture when the bottom seal plate closes the lower aperture and wherein the middle seal plate closes the lower aperture when the upper seal plate closes the upper aperture.

19. A substrate load lock as in Claim 18, wherein the upper seal plate has an upper surface subjected to atmospheric pressure and the middle seal plate has a lower surface subjected to atmospheric pressure, the upper surface of the upper seal plate being larger than and facing substantially opposite to the lower surface of the middle seal plate so that atmospheric pressure urges the upper seal plate against the upper seal of the upper aperture and the middle seal plate against the upper seal of the lower aperture when the sealable chamber has a vacuum therein.

20. A substrate load lock as in Claim 18, wherein the bottom seal plate has a lower surface subjected to

atmospheric pressure, and the middle plate has an upper surface subjected to atmospheric pressure, the lower surface of the bottom seal plate being larger than and facing substantially opposite to the upper surface of the middle seal plate so that atmospheric pressure urges the bottom seal plate against the lower seal of the lower aperture and the middle seal plate against the lower seal of the upper aperture when the sealable chamber has a vacuum therein.

21. A substrate load lock comprising:

a frame having a chamber formed therein, the chamber having an upper substrate receiving opening and lower substrate receiving opening; and

a moving support attached to the frame, the moving support having an upper substrate support area and a lower substrate support area, wherein the moving support reciprocates to alternately move the upper support area and the lower support area into the chamber, the upper support area begin moved through the upper substrate receiving opening and the lower support area being moved through the lower substrate receiving opening.

22. A substrate load lock as in Claim 21, wherein the moving support has seals to close the upper substrate receiving opening and the lower substrates receiving opening so that the chamber is isolated from an upper plenum of the load lock and a lower plenum of the load lock.

23. A substrate load lock as in Claim 21, wherein the moving support has an upper one of the seals, a middle one of the seals and a lower one of the seals, the upper substrate support area being located between the upper seal and middle seal and the lower substrate

support area being located between the middle seal and the lower seal.

24. A substrate load lock as in Claim 23, wherein the upper seal and middle seal respectively close the upper substrate receiving opening and the lower substrate receiving opening when the moving support moves the upper substrate support area into the chamber, and wherein the middle seal and lower seal respectively close the upper substrate receiving opening and lower substrate receiving opening when the moving support moves the lower substrate support area into the chamber.

25. A substrate load lock as in Claim 21, wherein the chamber has a substrate transport slot in a side of the chamber so that the chamber communicates with a processing chamber of a substrate processing device, the slot having a gate to isolate the chamber from the processing chamber in the processing device when the upper substrate receiving opening and the lower substrate receiving opening of the chamber are open.

26. A method for transporting a substrate between a substrate processing device and a supply module comprising the steps of:

transporting the substrate between a movable first substrate support area in a load lock and the supply module, the first substrate support area being located in an initial position wherein a first substrate transport mechanism for transporting substrates between the supply module and load lock has access to the first substrate support area;

moving the first substrate support area within the load lock from an initial position to a final position, wherein in the final position a second

substrate transport mechanism has access to the first substrate support area; and

transporting the substrate with the second substrate transport mechanism between the first substrate support area in the load lock and the substrate processing device.

27. A method for transporting a substrate as in Claim 26, wherein a second substrate support area of the load lock is moved within the load lock from an initial position to a final position when moving the first substrate support area, the first substrate transport mechanism having access to the second substrate support area when the second substrate support area is in its final position.

28. A method for transporting a substrate as in Claim 27, wherein the first substrate support area and the second substrate support area are connected to a common support movably mounted to the load lock.

29. A method for transporting a substrate as in Claim 26, wherein the step of transporting the substrate between the first substrate support area in the load lock and the substrate processing device comprises changing the environment within a first part of the load lock having the substrate support area therein while maintaining the environment of a second part of the load lock unchanged.

## ABSTRACT

1 A substrate load lock comprising a frame and a substrate  
2 support movably mounted to the frame. The frame forms at  
3 least three chambers. The substrate support has at least  
4 two separate support areas. The first one of the support  
5 areas is movable between the first one of the chambers.  
6 A second one of the support areas is movable between the  
7 second chamber and a third one of the chambers.



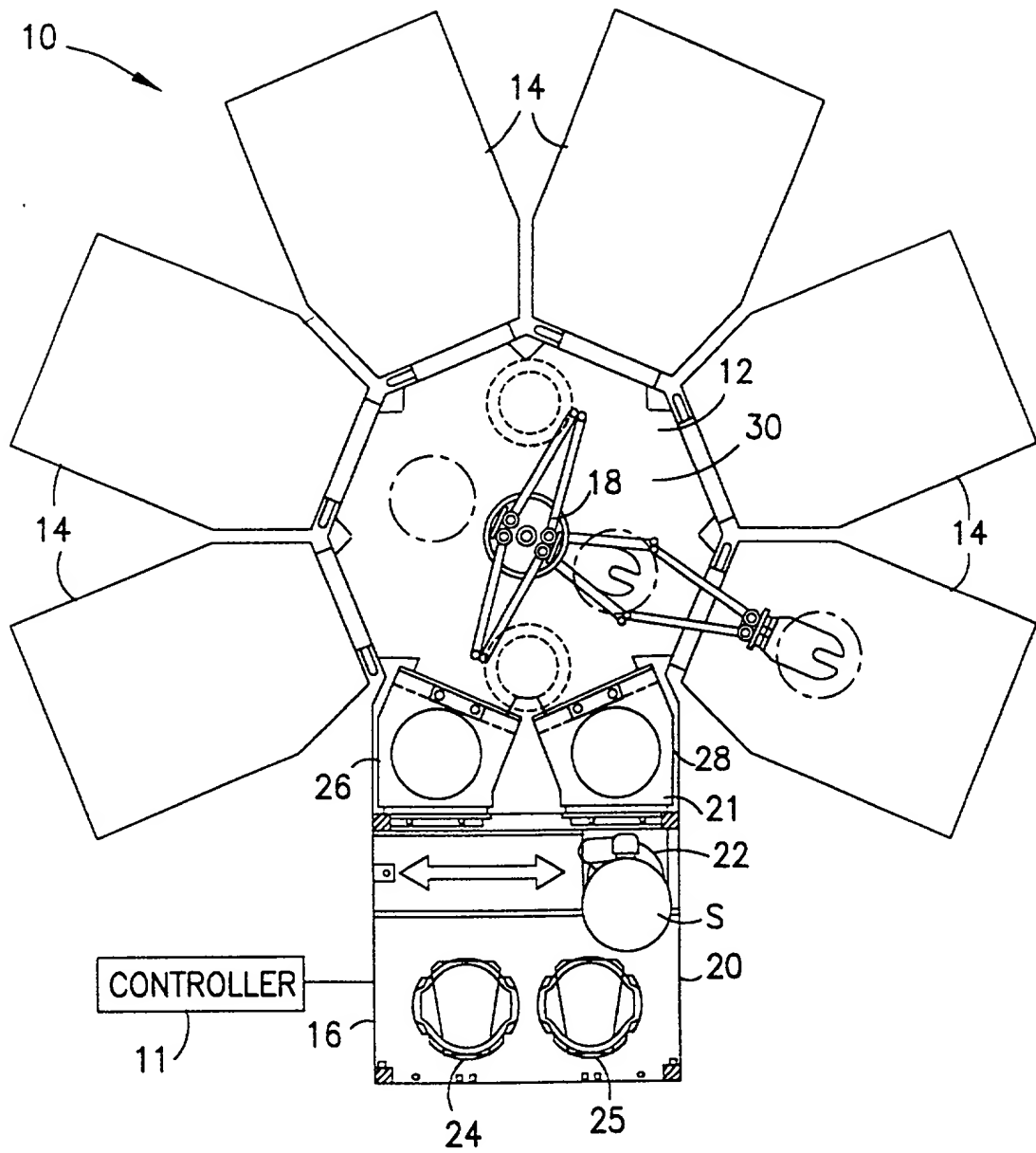
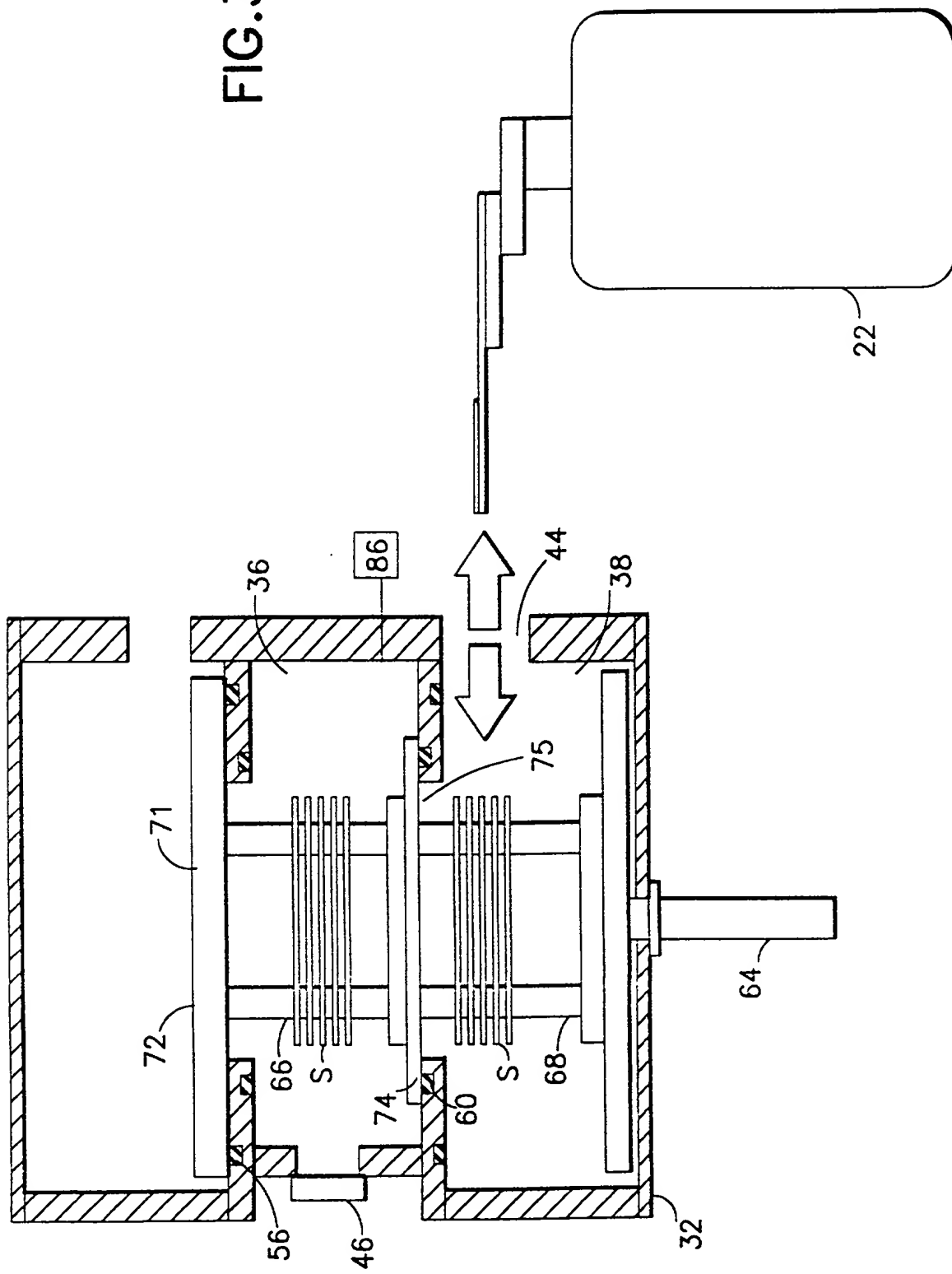


FIG. 1

[illegible]

FIG. 3A



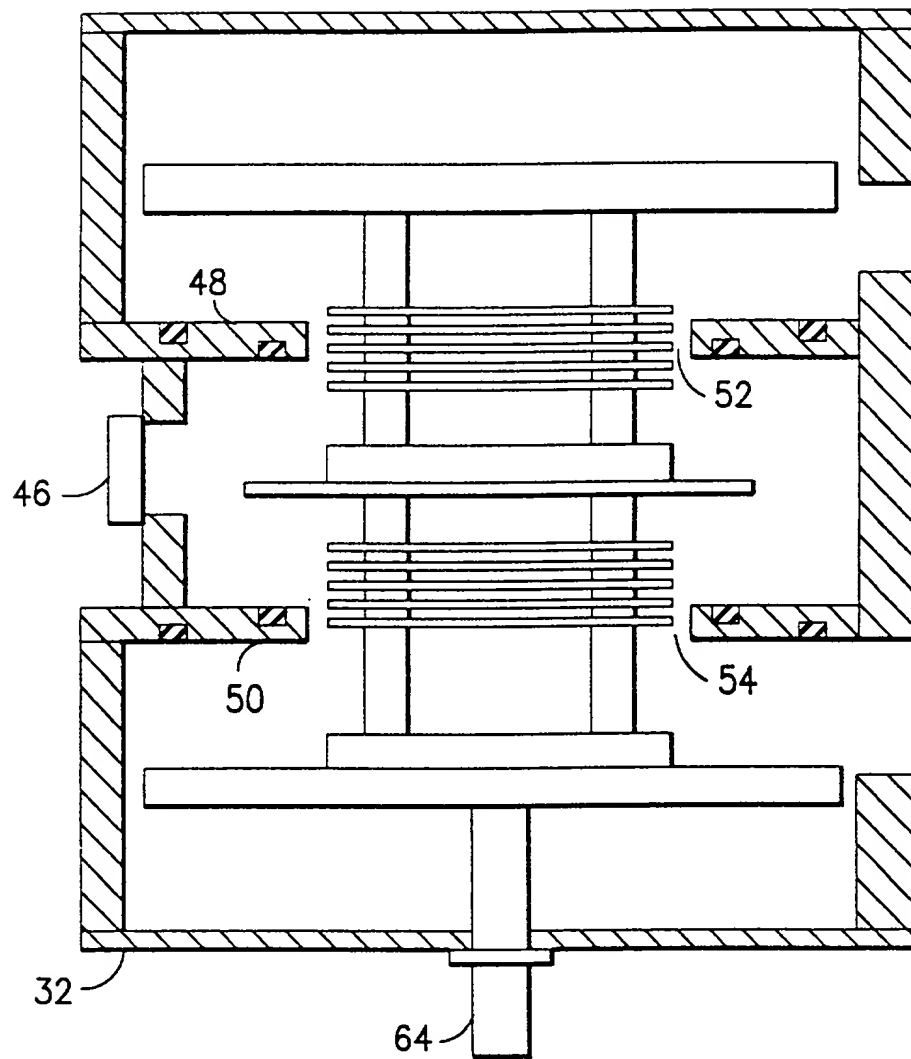


FIG.3B

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**COMBINED DECLARATION AND POWER OF ATTORNEY**

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL,  
CONTINUATION OR C-I-P)

---

As a below named inventor, I hereby declare that:

**TYPE OF DECLARATION**

This declaration is of the following type:

(check one applicable item below)

☒ original.

☐ design.

☐ supplemental.

*NOTE: If the declaration is for an International Application being filed as a divisional, continuation or continuation-in-part application, do not check next item; check appropriate one of last three items.*

☐ national stage of PCT.

*NOTE: If one of the following 3 items apply, then complete and also attach ADDED PAGES FOR DIVISIONAL, CONTINUATION OR C-I-P.*

☐ divisional.

☐ continuation.

☐ continuation-in-part (C-I-P).

**INVENTORSHIP IDENTIFICATION**

*WARNING: If the inventors are each not the inventors of all the claims, an explanation of the facts, including the ownership of all the claims at the time the last claimed invention was made, should be submitted.*

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

**TITLE OF INVENTION**

Substrate Processing Apparatus With Small Batch Load Lock

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## SPECIFICATION IDENTIFICATION

the specification of which:

(complete (a), (b) or (c))

(a) ☒ is attached hereto.

NOTE: "The following combinations of information supplied in an oath or declaration filed on the application filing date with a specification are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.63:

"(1) name of inventor(s), and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration on filing;

"(2) name of inventor(s), and attorney docket number which was on the specification as filed; or

"(3) name of inventor(s), and title which was on the specification as filed."

Notice of July 13, 1995 (1177 O.G. 60).

(b) ☐ was filed on \_\_\_\_\_, as ☐ Serial No. 0 / \_\_\_\_\_  
or ☐ \_\_\_\_\_  
and was amended on \_\_\_\_\_ (if applicable).

NOTE: Amendments filed after the original papers are deposited with the PTO that contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 CFR 1.67.

NOTE: "The following combinations of information supplied in an oath or declaration filed after the filing date are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.63:

"(1) name of inventor(s), and application number (consisting of the series code and the serial number; e.g., 08/123,456);

"(2) name of inventor(s), serial number and filing date;

"(3) name of inventor(s) and attorney docket number which was on the specification as filed;

"(4) name of inventor(s), title which was on the specification as filed and filing date;

"(5) name of inventor(s), title which was on the specification as filed and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration; or

"(6) name of inventor(s), title which was on the specification as filed and accompanied by a cover letter accurately identifying the application for which it was intended by either the application number (consisting of the series code and the serial number; e.g., 08/123,456), or serial number and filing date. Absent any statement(s) to the contrary, it will be presumed that the application filed in the PTO is the application which the inventor(s) executed by signing the oath or declaration."

Notice of July 13, 1995 (1177 O.G. 60).

(c) ☐ was described and claimed in PCT International Application No. \_\_\_\_\_, filed on \_\_\_\_\_ and as amended under PCT Article 19 on \_\_\_\_\_ (if any).

## ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56,

*(also check the following items, if desired)*

- ☒ and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent, and
- ☐ in compliance with this duty, there is attached an information disclosure statement, in accordance with 37 CFR 1.98.

### PRIORITY CLAIM (35 U.S.C. § 119(a)-(d))

I hereby claim foreign priority benefits under Title 35, United States Code, §§ 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

*(complete (d) or (e))*

- (d) ☒ no such applications have been filed.
- (e) ☐ such applications have been filed as follows.

NOTE: Where item (c) is entered above and the International Application which designated the U.S. itself claimed priority check item (e), enter the details below and make the priority claim.

**PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS  
(6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION  
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119(a)-(d)**

COUNTRY (OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 37 USC 119
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>

**CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S)**  
(34 U.S.C. § 119(e))

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

**PROVISIONAL APPLICATION NUMBER**

**FILING DATE**

60 / 044,490  
\_\_\_\_ / \_\_\_\_\_  
\_\_\_\_ / \_\_\_\_\_

4/21/97  
\_\_\_\_\_  
\_\_\_\_\_

**CLAIM FOR BENEFIT OF EARLIER US/PCT APPLICATION(S)  
UNDER 35 U.S.C. 120**

- ☐ The claim for the benefit of any such applications are set forth in the attached ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR CONTINUATION-IN-PART (C-I-P) APPLICATION.



**ALL FOREIGN APPLICATION(S), IF ANY, FILED MORE THAN 12 MONTHS  
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION**

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NOTE: If the application filed more than 12 months from the filing date of this application is a PCT filing forming the basis for this application entering the United States as (1) the national stage, or (2) a continuation, divisional, or continuation-in-part, then also complete ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR C-I-P APPLICATION for benefit of the prior U.S. or PCT application(s) under 35 U.S.C. § 120.

**POWER OF ATTORNEY**

I hereby appoint the following practitioner(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

*(list name and registration number)*

Clarence A. Green (24,622)  
Harry F. Smith (32,493)  
Mark F. Harrington (31,686)

*(check the following item, if applicable)*

- ☐ I hereby appoint the practitioner(s) associated with the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.
- ☐ Attached, as part of this declaration and power of attorney, is the authorization of the above-named practitioner(s) to accept and follow instructions from my representative(s).

SEND CORRESPONDENCE TO

DIRECT TELEPHONE CALLS TO:  
*(Name and telephone number)*

☒ Address

Mark F. Harrington  
Perman & Green, LLP  
425 Post Road  
Fairfield, CT 06430

Mark F. Harrington  
(203) 259-1800

☐ Customer Number \_\_\_\_\_

## DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

## SIGNATURE(S)

NOTE: Carefully indicate the family (or last) name, as it should appear on the filing receipt and all other documents.

Full name of sole or first inventor

Douglas

R.

Adams

(GIVEN NAME)

(MIDDLE INITIAL OR NAME)

FAMILY (OR LAST NAME)

Inventor's signature

*Douglas R. Adams*

Date

17 March

1998

Country of Citizenship

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Residence

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Post Office Address

5 Blueberry Hill Drive, Pepperell, MA 01463

Full name of second joint inventor, if any

(GIVEN NAME)

(MIDDLE INITIAL OR NAME)

FAMILY (OR LAST NAME)

Inventor's signature

Date

Country of Citizenship

Residence

Post Office Address

Full name of third joint inventor, if any

(GIVEN NAME)

(MIDDLE INITIAL OR NAME)

FAMILY (OR LAST NAME)

Inventor's signature

Date

Country of Citizenship

Residence

Post Office Address

(check proper box(es) for any of the following added page(s)  
that form a part of this declaration)

- ☐ **Signature** for fourth and subsequent joint inventors. Number of pages added \_\_\_\_\_.

\* \* \*

- ☐ **Signature** by administrator(trix), executor(trix) or legal representative for deceased or incapacitated inventor. Number of pages added \_\_\_\_\_.

\* \* \*

- ☐ **Signature** for inventor who refuses to sign or cannot be reached by person authorized under 37 CFR 1.47. Number of pages added \_\_\_\_\_.

\* \* \*

- ☐ Added page for **signature** by one joint inventor on behalf of deceased inventor(s) where legal representative cannot be appointed in time. (37 CFR 1.47)

\* \* \*

- ☐ Added pages to combined declaration and power of attorney for divisional, continuation, or continuation-in-part (C-I-P) application.

☐ Number of pages added \_\_\_\_\_

\* \* \*

- ☐ Authorization of practitioner(s) to accept and follow instructions from representative.

\* \* \*

(if no further pages form a part of this Declaration,  
then end this Declaration with this page and check the following item)

- ☒ This declaration ends with this page.